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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Filing Date: November 13, 2001

Examiner: Not Assigned

Serial No.: 10/007,823

Group Art Unit: Unknown

Title: **A HEARING AID WITH ERROR PROTECTED DATA STORAGE**

Commissioner for Patents  
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# Kongeriget Danmark

Patent application No.: PA 2000 01702  
Date of filing: 14 November 2000  
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Varemærkestyrelsen  
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Taastrup, 29 November 2001

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14 NOV. 2000

Modtaget

72831

HHB/CJ

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A HEARING AID WITH ERROR PROTECTED DATA STORAGE.

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## A HEARING AID WITH ERROR PROTECTED DATA STORAGE

### FIELD OF THE INVENTION

5 The present invention relates to an improved method of storing data within a persistent data space of a hearing aid and a hearing aid utilising the improved storage method so as to prevent that erroneous or corrupted data are written into and/or loaded from the persistent data space due to unexpected and uncontrollable power supply failures in the hearing aid.

10

### BACKGROUND OF THE INVENTION

It is generally desirable to have a possibility of writing various hearing aid associated data to a persistent data space within the hearing aid during its normal operation. A hearing aid  
 15 provided with such a data storage capability will be able to record or log information within the persistent data space about various hearing aid parameters such as a patient's utilisation pattern of a number of user-selectable listening programs, volume control settings, sound environment information based on input sound pressure level statistics etc. Furthermore, the data storage capability also allows the hearing aid, or rather the  
 20 hearing aid's processor, to execute slowly converging adaptive signal processing algorithms, in particular algorithms that have so small adaptation rates that the algorithms often are unable to converge during a typical daily utilisation time of the hearing aid, i.e. a time period somewhere between 6-12 hours. One example of such a slowly converging algorithm, relating to long-term balancing of average signal levels of a pair of  
 25 microphones, is disclosed in the present applicant's co-pending application PA 2000 01407.

Writing data to the persistent data space during normal operation of the hearing aid poses, however, a significant problem that has not been properly addressed by the prior  
 30 art; In existing hearing aid designs, the user is allowed to remove or interrupt the normal power source, often a single 1.3 Volt Zinc-Air battery, at arbitrary instants in time by simply opening a battery compartment or actuating a mechanical power switch. If the processor is in a process of writing data to the persistent data space when such an uncontrollable power failure occurs, those data will inevitably be corrupted. Handling and  
 35 securing correct writing of data to the persistent data space during normal operation of the

hearing aid is accordingly more difficult than the well-known writing of programming data to the persistent data space in the initial fitting situation where a connected host programming system secures that correct data are loaded into the aid. In this latter situation, a fitting program can easily be adapted to confirm that down-loaded data are  
 5 correct, e.g. by using a simple read-back and compare function.

A hearing aid with data logging capability is disclosed in US 4,972,487 in the form of a digitally programmable hearing aid that includes a data logging circuit and provides a number of different user-selectable listening programs. The data logging circuit is utilised  
 10 to record log-data relating to how many times the user switches between the listening programs and a utilisation time of each of the listening programs. The recorded log-data are stored in a battery backed-up RAM area so that the logged-data are retained when a battery supply of the hearing aid is interrupted. A bi-directional serial programming interface is furthermore included in the hearing aid making it possible for a host  
 15 programming system, typically located in a dispenser's office, to read and display the logged-data. However, this reference contains no suggestion of how to detect or correct data errors to secure that the logged data are valid.

DE 197 34 723 to Siemens Audiologische Technik discloses a Digital Signal  
 20 Processing(DSP) hearing aid adapted to perform an internal detection and/or correction of errors in data storage and data transmission operations between a secondary storage area and a working memory area. The proposed error detection or correction schemes are based on well-known checksum, parity or Hamming coding techniques. However, the proposed use of Hamming coding techniques to detect and correct data errors are costly  
 25 in terms of memory overhead and in terms of processing power and/or dedicated hardware such as test elements adapted to perform the necessary computations on the data. Furthermore, such Hamming coding schemes can typically only detect and correct a minor parts of the bits in a corrupted set of data and will therefore not be able to correct errors within a completely corrupted data set which may be the result of uncontrollable  
 30 power failures in the power supply of the hearing aid.

Accordingly, there is a need to provide a simple, cost-effective and reliable method of writing and storing values of various hearing aid associated variables in a persistent or retained data space, typically arranged inside an EEPROM device, of the hearing aid  
 35 during normal operation of the aid.

## SUMMARY OF THE INVENTION

One object of the invention is to provide a hearing aid and a corresponding method that  
 5 allow various type of data generated by the processor during normal operation of the hearing aid to be reliably written to a persistent memory space of the hearing aid.

## DESCRIPTION OF THE INVENTION

10 A first aspect of the invention relates to a method of saving data within a persistent data space of a hearing aid, the method comprising the steps of:

processing an input signal by a processor according to a predetermined algorithm to generate a processed output signal,

15

generating a plurality of data sets, representing respective values of predetermined hearing aid associated variable(s), by the processor,

20 writing the plurality of data sets to respective storage areas within the persistent data space,

indicating a valid data set, of the plurality of data sets, by setting a value of at least one data variable in the persistent data space.

25 In the present specification and claims, the term "processor" designates one or several separate processors and its/their associated memory circuitry, either arranged on a common integrated circuit substrate or distributed over several integrated circuit substrates. The processor may comprise a Digital Signal Processor (DSP) such as a proprietary or commercially available fixed or floating point DSP circuit or core. The DSP  
 30 may be a software programmable type adapted to apply one or several different signal processing algorithms to the input signal in accordance with respective instructions set(s) held in an associated program RAM during execution of these algorithms. Alternatively, the processor may be constituted by, or at least comprise, a hard-wired DSP designed to execute one or several fixed signal processing algorithm(s) in accordance with respective  
 35 fixed set(s) of instruction(s) from an associated logic controller. If the processor comprises

two or more separate processors, e.g. a Digital Signal Processor (DSP) and an industry standard micro-controller, each processor may be tailored to perform only certain operations of the claimed method so as to divide a total computational load into appropriate subtasks, where each such subtask may be tailored to specific characteristics of its associated processor.

In the present specification and claims, the term "persistent data space" designates a memory space wherein data are retained or held during time periods where the hearing aid's normal power supply source, typically a 1.3 – 1.5 Volt Zinc-Air battery, is interrupted or discharged. This may be accomplished by locating the persistent data within one or more non-volatile memory devices such as EPROM, EEPROM and Flash-memory devices. Such non-volatile memory devices may be provided in a form of external and separate memory circuits communicating with the DSP over a suitable, typically serial, programming interface or the non-volatile memory device may be integrated with the DSP to provide a single chip solution. Alternatively, the persistent data space may be located within a volatile memory type such as a RAM or register file connected to a suitable back-up power supply source, such as a back-up battery or a supercharge capacitor.

The plurality of data sets represent respective values of predetermined a hearing aid associated variable or variables. Each data set may comprise one or several DSP algorithm parameter(s) and/or various other types of hearing aid associated variables relating to the operation of the hearing aid or a user interface of the hearing aid. The latter variables may be statistical data relating to the hearing aid user's selection of preset listening programs, long-term or short-term spectral properties of microphone input signals, utilisation time of the hearing aid etc. A parameter of the DSP algorithm may be a volume control setting or a gain multiplier of a gain scaling operation within an input signal channel of the hearing aid. As previously-mentioned may such an algorithm be designed to have a very small adaptation rate to match long-term drift in matching characteristics of the pair of microphones.

30

According to such an embodiment of the invention, appropriate gain multiplier values for the gain scaling operation are continuously calculated by the processor based on running average signals levels from the microphones. The determined gain multiplier values are written at regular time intervals, and in an alternating manner, to the first and second storage area within the persistent data space. Consequently, if one of the gain multiplier

35

values is corrupted by a power failure during writing to the persistent data space, there is no significant loss of information since the last but one gain multiplier value may be retrieved from the valid data set indicated by the at least one data variable. Accordingly, the adaptive microphone matching algorithm will not need to be restarted, e.g. with a default value of the gain multiplier, and thus for a significant period of time deteriorate the matching between the microphones and thereby compromise a performance of the hearing aid.

After one data set of the plurality of data sets has been successfully written to the persistent data space, the at least one data variable in the persistent data space is set to a value or state which indicates that the data set in question is the valid set of data. The at least one data variable may therefore advantageously be set to its correct value immediately after a data set has been successfully written to its storage area to secure that the most recent data set is identified as the valid set of data. The plurality of data sets are preferably written to their respective storage areas within the persistent data space in an intermittent manner.

The advantages of the above-described scheme will be explained in the following: In case a power failure happens during a write cycle of an updated set of data, containing updated value(s) of the predetermined hearing aid associated variable(s), to the persistent data space, the data set in question will be corrupted. However, since the power failure will happen prior to the intended subsequent setting of the value of the data variable, which would have indicated the set of data in question to be valid, the at least one data variable will never be altered and thus still correctly indicate the previous data set to be the valid set of data. Alternatively, if the set of data in question is successfully written to the persistent data space and the at least one data variable correspondingly set to indicate this, it can safely be assumed that this set of data is valid because otherwise would the value of the at least one data variable never have been set.

Naturally, at a given point in time, each of the plurality of data sets may constitute a valid data set in the sense that none of them have been corrupted by e.g. a power failure, which presumably should be a relatively rare event. In that situation, the at least one data variable merely serves to indicate which data set that most recently has been updated.

The crucial point remains, however, that the inventive use of a duplicate storage technique for a data set secures that at least one of the data sets always contains

uncorrupted data on which the processor can safely rely. Since DSP based hearing aids usually will perform a processor reboot after a power failure has occurred, or after actuation of a power ON/OFF switch, the processor may advantageously be adapted to access or read the value of the at least one data variable to determine which of the data sets to use during such a reboot process.

According to a preferred embodiment of the invention, the plurality of data sets are constituted by a first and a second data set and the at least one data variable comprises a single binary data variable, having only two possible values or states, indicating the valid data set. Thereby, it is avoided that power failures that may happen during writing or setting of the value of the at least one data variable in the persistent data space could lead to an ambiguous value of the at least one data variable.

Each data set may be stored within an associated storage area of the persistent data space together with an associated data variable that indicates whether the set of data in question is valid. The associated data variables may be represented by respective counter values, e.g. inserted in respective headers in an initial part of each set of data. The counter values may be related to a clock period counter of the hearing aid and therefore represent respective values of the hearing aid's accumulated utilisation time. Each counter value may be written to its associated data set immediately after a successful writing of that data set has been completed. Thereby, each set of data will comprise a time stamp, that will indicate the time at which the data set in question was stored. Consequently, the valid set of data, among the plurality of data sets, may be assumed to be that set of data which has the highest counter value, i.e. the most recently stored set of data. According to this embodiment of the invention, each set of data contains an associated data variable that indicates whether the set of data in question is valid. The processor will, e.g. at boot time, be able to determine which of the plurality of stored data sets that is the valid data set based on the values of the plurality of data variables.

30

Alternatively, the at least one data variable may be constituted by single data variable, capable of assuming more than two differing values so as to indicate which of the plurality of data sets that is valid even if three or more data sets are utilised. The data variable may accordingly function as a pointer to the valid set of data either by directly or indirectly pointing to the valid data set. In such an embodiment of the invention, the data variable

may advantageously be stored in a storage area within the persistent data space separate from the storage areas of the plurality of data sets.

In the above-mentioned embodiments of the invention that utilises a non-binary data variable or several data variables, each of the variables will typically have a length of 8-32 bits and may therefore be vulnerable to corruption if a power failure happens during a write sequence of a data variable. To combat this, each data set, of the plurality of data sets, may be associated with an error detection or error correction code within the persistent data space that allows the processor to determine whether a given data set is corrupted before this data set is loaded into the processor. If the initially indicated set of data has an erroneous checksum, the processor may proceed by skipping that set of data and thereafter identify and load another data set according to a predetermined order, e.g. the data set that has the most recent time stamp or the highest associated counter value after the initial set of data has been skipped.

The predetermined algorithm may comprise a number of separate signal processing algorithms, such as digital signal processing algorithms, that each implements a particular signal processing operation on the input signal or a signal derived therefrom such as multichannel compression, adaptive microphone matching, frequency response shaping, adaptive feedback cancellation etc. The plurality of data sets may comprise respective parameter values of these separate signal processing algorithms. Furthermore, the data sets may comprise respective signal events associated with a user interface part of the hearing aid, such as preset switch operations, volume control manipulations and/or statistical information related to these events.

According to an important embodiment of the invention, a part of each of the data sets represent an accumulated utilisation time value of the hearing aid. The hearing aid is adapted to, regularly, determine its accumulated utilisation time and record a current value of the accumulated utilisation time by writing it to the data sets within the persistent data space in an intermittent manner. This embodiment of the invention allows the processor to control one or several functions of the hearing aid based on the accumulated utilisation time. Such a hearing aid may be sold on a subscription arrangement and therefore adapted to cease operating after a certain predetermined prescription time period has expired. By storing respective accumulated utilisation time values in the plurality of data sets, it can be secured that even if one of the data sets at some point in

time gets corrupted, it is always possible for the processor to recover a sufficiently accurate value of the accumulated utilisation time from one of the other data sets and thus prevent e.g. a premature and incorrect interruption of the hearing aid's operation.

- 5 If the retained memory area is located within an EPROM or EEPROM or flash memory device, it may be desirable to limit the total number of times that a data set is written to this type of memory device. EEPROM and other types of non-volatile memory are usually capable of withstanding only a limited number of write cycles, such as 10.000 or 100.000 write cycles. Therefore, data of each of the plurality of data sets may updated at a time
- 10 interval between 1 – 60 minutes or more preferably between 5 – 20 minutes. Another method of prolonging the lifetime of the persistent data space is to use a large number of data sets and corresponding storage areas, e.g. 4 - 8 data sets and storage areas, and thereby reduce the number of times that a given storage area in the persistent data space will be written during the hearing aid's lifetime. For some applications, where the data sets
- 15 are large, it may clearly be impractical to occupy memory space for such a large amount of data. On the other hand, for small data sets, that each may occupy only a few bytes or words, it is possible to use a large number of data sets, such as the above-mentioned 4 - 8 data sets, and thereby prolong the lifetime of the memory device.
- 20 The storage area of the at least one the data variable may be located adjacent to one of the storage areas or each data variable of a plurality of data variables may be stored inside its associated storage area. If the persistent data space is arranged inside a memory device which is divided into a number of predetermined and distinct memory segments, it may be advantageous to arrange each storage area, and consequently each
- 25 data set, wholly in its own distinct memory segment and also locate the at least one data variable in its own memory segment.

- A second aspect of the invention relates to a hearing aid comprising a persistent data space and a processor adapted to perform any of the above-mentioned methods of
- 30 saving data in the persistent data space. The processor may comprise a software programmable Digital Signal Processor adapted to perform the method under control of a predetermined set of processor instructions that may be loaded into the DSP's program RAM from the persistent data space at boot time.

A third aspect of the invention relates to a method of saving data within a persistent data space of a hearing aid. The method comprising the steps of:

processing an input signal by a processor according to a predetermined algorithm to  
 5 generate a processed output signal,

generating a plurality of data sets, representing respective values of predetermined hearing aid associated variable(s), by the processor,

10 generating for each data set, an associated error detection code,

writing the plurality of data sets and the associated error detection codes to respective storage areas within the persistent data space.

15 According to this third aspect of the invention, the use of a corrupted data set is avoided by storing the plurality of data sets, i.e. at least two data sets, together with respective associated error detection codes. When the processor has to load a data set from the persistent data space to determine appropriate values of the hearing aid associated variable(s), it may start out by loading a first data set and the error detection code  
 20 associated with that data set. Thereby, the processor will be able determine whether the currently loaded data set is valid or not. If it is determined that the currently loaded data set is invalid, the processor may proceed by loading a second data set and its error detection code from the persistent data space and once again determine whether this second data set is valid or not. Usually, if the first data set has been corrupted by e.g. a  
 25 power failure, the second data set will be valid because the latter has been written before the power failure took place. As previously-mentioned, a data set may be corrupted, e.g. due to an uncontrollable power supply failure, to an extent that makes it impossible to recover that data set by commonly used error correction codes. Contrary to this, the present method of storing at least two data sets, preferably in an alternating manner,  
 30 secures that at least one valid data set always will be stored in the persistent data space so that appropriate values of the predetermined hearing aid associated variable(s) can be recovered.

According to this third aspect of the invention, the processor will not be capable of  
 35 Identifying the valid data set by reading a value of a data variable which indicates the valid

data set, so instead a search strategy is used to go through, from an arbitrary starting point, the stored data sets until a valid data set is located. Once a valid data set has been identified, the processor may proceed by using this data set even though it can not be guaranteed that that data set really is the most recently stored data set. However, for  
 5 many applications, this will not constitute a significant problem, since this potential loss of the most recent data set effectively corresponds to adjusting values of the hearing aid associated variables back to those values which they had e.g. 5 – 20 minutes ago. Finally, if it is required to be able to identify the most recently stored data set, one or several appropriate data variables pointing to, or indicating, the valid data set may be added to  
 10 the persistent data space as previously-described in connection with the first aspect of the invention.

The method may comprise the further steps of reading a first data set and its associated error detection code from the persistent data space during power on of the hearing aid  
 15 and determine whether the first data set is a valid data set based on the associated error detection code. The first data set is skipped if it is invalid and data set(s) and its/their associated error detection code(s) is/are read from the persistent data space until a valid data set is identified. When a valid data set is found, values of the predetermined hearing aid associated variable(s) represented by the valid data set is applied to the hearing aid.  
 20 The values of the predetermined hearing aid associated variable(s) may be loaded into an operational part of the hearing aid processor's data RAM and/or a general purpose register(s).

If the processor determines that none of the data sets in the persistent memory contains  
 25 valid data, the processor may notify the hearing aid user of the fact that an irrecoverable error condition has occurred by introducing a distinct notification signal into the processed output signal. Alternatively, an occurrence of an irrecoverable error condition may be conveyed to the hearing aid user by a visual signal on display means integrated with the aid. The hearing aid is preferably adapted to halt all processing of the input signal and/or  
 30 mute the processed output signal once the notification signal has been issued to avoid presenting annoying, or even harmful, sound pressure levels to the hearing aid user caused by utilising erroneous value(s) of the predetermined hearing aid associated variable(s). Another possibility, which may be acceptable for some applications, is to completely discard the contents of the plurality of data sets if an irrecoverable error  
 35 condition occurs and instead revert to using default value(s) of the predetermined hearing

aid associated variable(s). This latter embodiment of the invention has the advantage that the user is not left in an unaided situation.

A fourth aspect of the invention relates to a hearing aid comprising a persistent data  
5 space and a processor adapted to perform a method of saving data according to the above-mentioned third aspect of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

10 A preferred embodiment of the present invention in the form of a software programmable DSP based hearing aid is described in the following with reference to the drawings, wherein

Fig. 1 shows a simplified block diagram of three-chip DSP based hearing aid according to  
15 the invention,

Fig. 2 illustrates a memory configuration of a persistent data space holding a first set of data, a second set of data and a data variable in the three-chip DSP based hearing aid.

#### 20 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The block diagram of Fig. 1 illustrates a PC based host programming system 16 connected to a bi-directional programming data bus 17 of the DSP hearing aid 1 through and an interface device 15 so as to allow a PC based host programming system 16 to  
25 transfer software programs and/or associated data to the DSP hearing aid 1. During an initial fitting session in a hearing aid dispenser's office, subroutines or an entire software program can be loaded into and permanently stored in an industry standard type of serial EEPROM 14, capable of retaining its data when the normal power supply (not shown) of the hearing aid 1 is interrupted. The software program is loaded into a programme RAM  
30 10 of the DSP 6 at boot time after power has been turned on in the hearing aid 1 while data variables such as algorithm parameters are loaded into a data RAM 11 at boot time.

The software program comprises a number of signal processing algorithms running on the DSP 6 in order to process digitised versions of microphone input signals generated from  
35 hearing aid microphones 2a and thereby provides a processed output signal to a hearing

aid speaker or receiver 13. The software program furthermore comprises an EEPROM write subroutine adapted to store various hearing aid associated variables, including a 16 bit value of a gain multiplier, generated or provided by the DSP 6 within a predetermined storage area (20, Fig. 2) of the EEPROM 14.

5

The software program may furthermore comprise a number of software routines or sub-programs responsible for handling a user interface part of the hearing aid that generates various parameter values or signal events associated with a number of user operable controls (not shown) provided on the hearing aid.

10

Fig. 2 illustrates a preferred structure of the predetermined storage area 20 wherein a first storage area 25 is adapted to hold a first set of data, a second storage area 30 is adapted to hold a second set of data and a data variable within a valid data map 35 points to, or indicates, which of the first and second storage areas contains valid data. For practical reasons, the size of the valid data map 35 has been selected to two bytes, but the data variable stored therein can only assume one of two possible values, zero or a value different from zero. Each of the first and second storage areas comprises 64 bytes which is the size of a so-called "page", i.e. a type of predetermined memory segment, in the preferred EEPROM 14. Each storage area is therefore positioned wholly within its own dedicated page of the EEPROM 14 so that even if all contents, including the data set in question, in that page for some reason get corrupted, the other data set in the other page will be left unaffected.

The valid data map 35 is furthermore also located in its own dedicated page. The provision of separate pages for the data sets and valid data map secures that power failures, or other data error-inducing events, happening while a data are written to a page can be confined to that page or storage area.

In the present embodiment of the invention, the first and second set of data comprise respective values of the gain multiplier in one of two input signal channels associated with the analogue-to-digital converters 4 (A/Ds). During normal operation of the DSP based hearing aid 1, updated values of this gain multiplier are continuously calculated by a microphone matching subroutine of the software program and intermittently written to the first and second storage areas 25, 30, respectively, at regular time intervals. The current value of the gain multiplier is derived from power estimates of the digitised versions of

microphone input signals so as to compensate for any difference between average signal levels of the microphone input signals. This adaptive or dynamic gain matching scheme secures that long-term matching of responses of the omni-directional microphones 2a is maintained so as to provide optimum directional characteristics in the DSP hearing aid 1  
5 when operated in a directional mode.

At boot time, the DSP 6 reads the value of the data variable from the valid data map area 35 and loads the gain multiplier from the indicated set of data into an internal register of the DSP 6. Data stored within each of the first and second storage areas are also  
10 provided with an associated checksum 40 to make it possible for the DSP 6 to detect whether the data contents has been corrupted by one or a few isolated bit errors that may be introduced during a read/write sequence of the first or second set of data. To support an optimum degree of system safety, the DSP 6 may advantageously be adapted to at boot time start out by reading the value of the data variable and load the indicated set of  
15 data into an intermediate register or storage area of the DSP 6. Thereafter, the DSP 6 may calculate a checksum of the set of data that are held in the intermediate register and determine whether the checksum of these data is correct or not. If the checksum is incorrect the processor may skip the data and thus avoid that the corrupted data are loaded into an operational register or storage area of the DSP 6. Clearly, other types of  
20 error detection and/or correction codes could also be applied to the first and second data sets such as Hamming codes, parity etc.

If the checksum of the presently loaded set of data, unexpectedly, turns out to be incorrect as previously-mentioned, the DSP 6 may proceed to read the other set of data from the  
25 persistent data space 20, because this other set of data typically will contain useable data, albeit slightly older than the initially indicated set of data. The DSP 6 may use these older set of data as an operational set of data provided that the associated checksum is correct. On the other hand, if the checksum of these older data is wrong also, it is preferred to either revert to using a default value of the parameters stored in the sets of data, i.e. the  
30 gain multiplier in the present case, or interrupt the operation of the hearing aid after the user has been alerted about the encountered error condition, e.g. by emitting a particular audible error signal or a displaying a visual error signal.

The EEPROM 14 included in the present embodiment of the invention is an external  
35 industry standard device of a serial type wherein a complete write sequence of a data set

requires a significant amount of time. When the data set contains about 64 bytes, the write sequence may be as long as 20 ms and therefore must the software program of the DSP 6 be adapted to handle such a long write sequence without introducing audible and annoying drop outs in the processed output signal to the hearing aid user. This may be accomplished by including a hardware or software based dedicated state machine within the DSP 6 to handle the EEPROM write task in parallel with the processing of the input signal or signals. The present embodiment of the invention uses a software based dedicated state machine that utilises or steals suitable instruction cycles from the DSP 6 within a block based processing of the input signals. Alternatively, the persistent data space could be integrated on the same die as the DSP 6 in form of a customised EEPROM circuit or a RAM circuit with a backup power supply. In this situation, it may be feasible, depending on the amount of data, to write the entire first or second data set of data to the persistent data space without having to use the above-described state machine.

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## CLAIMS

1. A method of saving data within a persistent data space of a hearing aid, the method comprising the steps of:

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processing an input signal by a processor according to a predetermined algorithm to generate a processed output signal,

generating a plurality of data sets, representing respective values of predetermined

10 hearing aid associated variable(s), by the processor,

writing the plurality of data sets to respective storage areas within the persistent data space,

15 indicating a valid data set, of the plurality of data sets, by setting a value of at least one data variable in the persistent data space.

2. A method according to claim 1, wherein the processor reads the value of the at least one data variable during power on of the hearing aid to identify the valid data set of the

20 plurality of data sets.

3. A method according to claim 1, wherein the plurality of data sets are written to their respective storage areas in an intermittent manner.

25 4. A method according to any of the preceding claims, wherein the plurality of data sets are written to the persistent data space during normal operation of the hearing aid.

5. A method according to any of the preceding claims, wherein the plurality of data sets comprise respective data representing volume control settings of a volume control of the

30 hearing aid.

6. A method according to any of the preceding claims, wherein the plurality of data sets comprise respective data representing accumulated utilisation time values of the hearing aid.

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7. A method according to any of the preceding claims, wherein the plurality of data sets comprise respective data representing values of signal processing parameters of the predetermined algorithm.

5 8. A method according to any of the preceding claims, wherein the persistent data space is arranged in one or several memory device(s) selected from the group consisting of: (EEPROM, EPROM, Flash Memory, RAM powered by a back-up voltage).

9. A method according to any of the preceding claims, wherein each data set of the  
10 plurality of data sets is written to the persistent data space at regular time intervals, the time interval being between 5 minutes and 60 minutes.

10. A method according to any of the preceding claims, wherein the at least one data variable is stored within the persistent data space in a storage area separate from the  
15 storage areas of the plurality of data sets.

11. A method according to any of claims 1-9, wherein each data set comprises a data variable indicating whether that data set is the valid data set.

20 12. A method according to claim 11, wherein the data variables of the plurality of data sets are represented by respective counter values.

13. A method according to any of the preceding claims, wherein each data set of the plurality of data sets is associated with an error detection or error correction code within  
25 the persistent data space.

14. A method according to any of the preceding claims, wherein the plurality of data sets are constituted by a first and a second data set, and

30 the at least one data variable comprises a single binary data variable indicating the valid data set.

15. A method of saving data within a persistent data space of a hearing aid, the method comprising the steps of:

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processing an input signal by a processor according to a predetermined algorithm to generate a processed output signal,

generating a plurality of data sets, representing respective values of predetermined  
5 hearing aid associated variable(s), by the processor,

generating for each data set, an associated error detection code,

writing the plurality of data sets and the associated error detection codes to respective  
10 storage areas within the persistent data space.

16. A method according to claim 15, comprising the further steps of:

reading a first data set and its associated error detection code from the persistent data  
15 space during power on of the hearing aid,

determining whether the first data set is a valid data set based on the associated error detection code,

20 skipping the first data set if it is invalid,

reading data sets and their associated error detection codes from the persistent data space until a valid data set is identified,

25 applying values of the predetermined hearing aid associated variable(s) represented by the valid data set to the hearing aid.

17. A method according to claim 16, comprising the further steps of:

30 notifying a hearing aid user of an irrecoverable error condition within the hearing aid by introducing a distinct notification signal into the processed output signal in case that none of the data sets contain valid data.

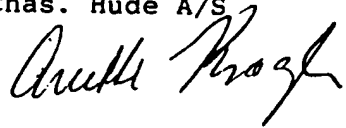
18. A hearing aid comprising a persistent data space and a processor adapted to perform  
35 a method of saving data according to any of claims 1-14.

19. A hearing aid according to claim 18, wherein the processor comprises a Digital Signal Processor.

5 20. A hearing aid comprising a persistent data space and a processor adapted to perform a method of saving data according to any of claims 15-17.

for GN ReSound A/S

Chas. Hude A/S

A handwritten signature in black ink, appearing to read "Arvid Krogh". The signature is written in a cursive, flowing style.

14 NOV. 2000

Modtaget

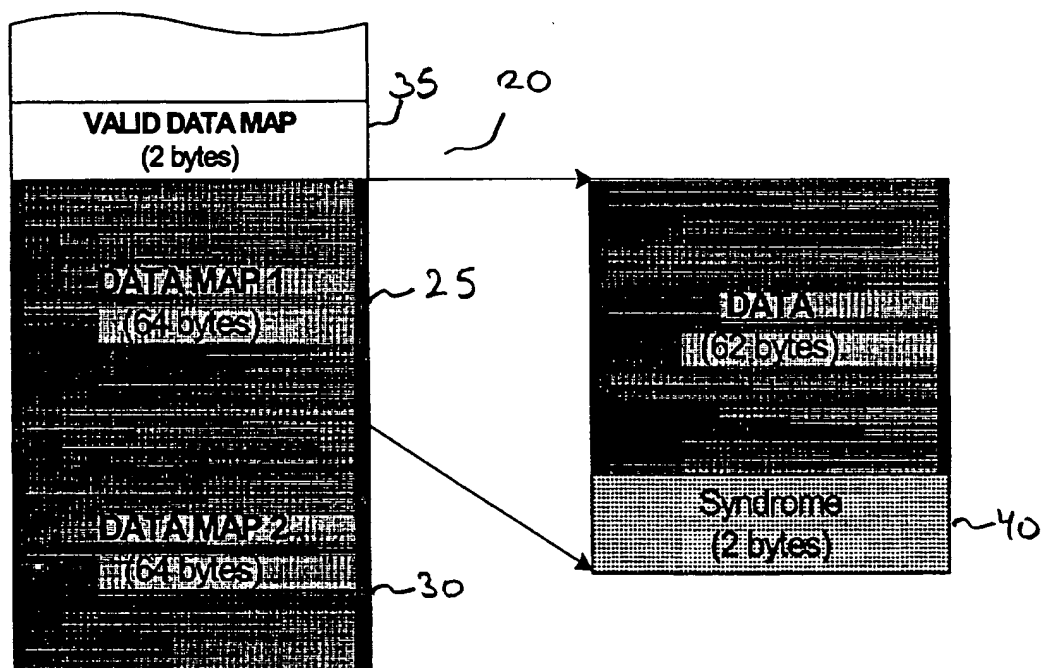


Fig. 2

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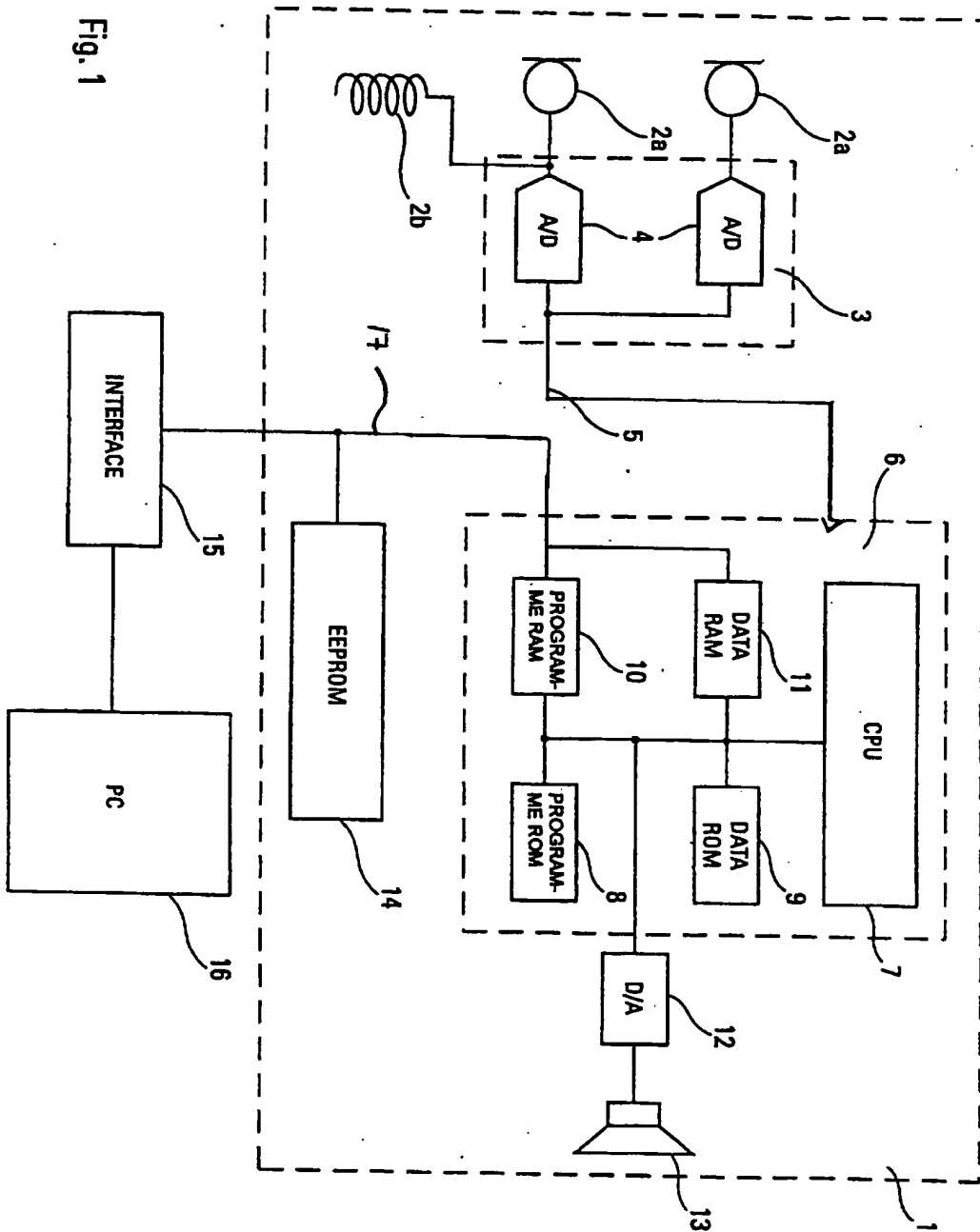


Fig. 1